

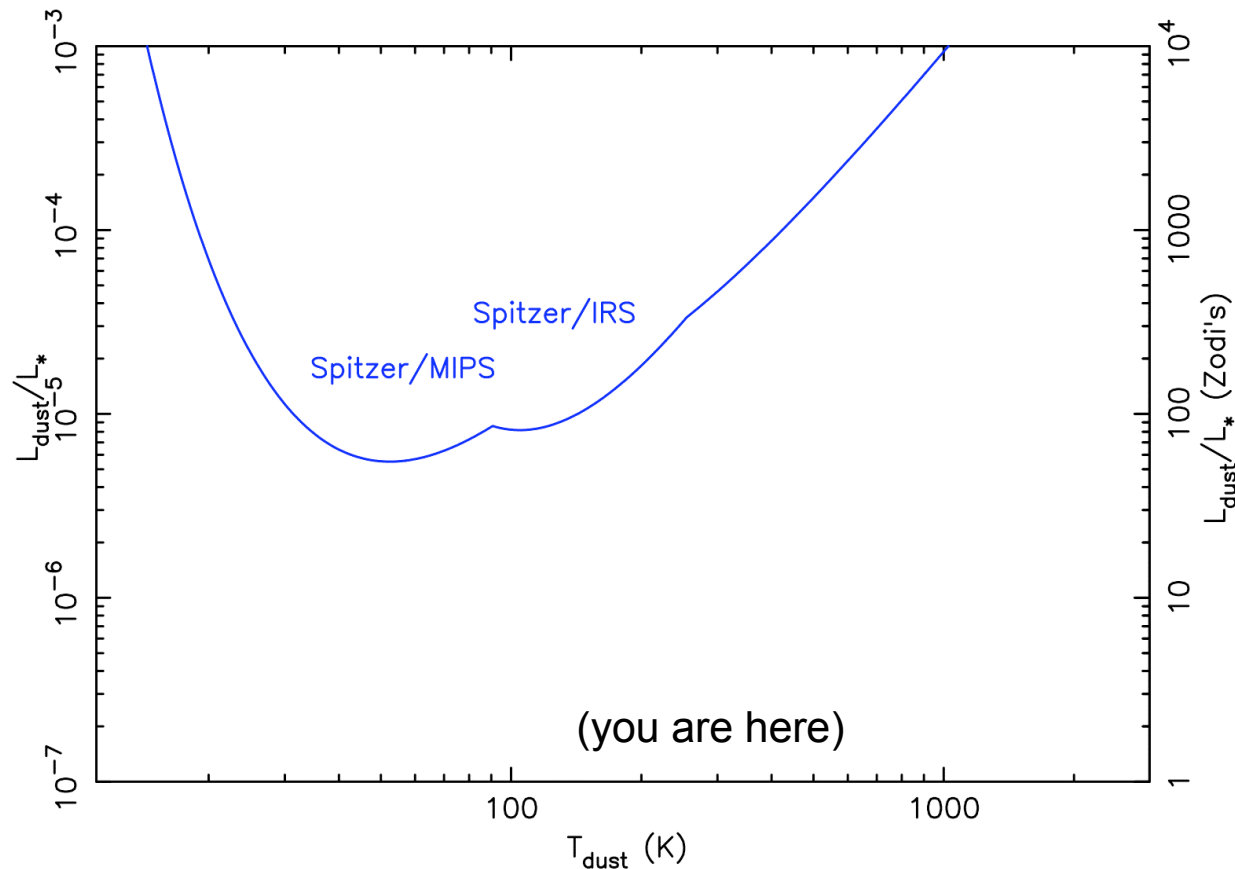
Debris Disks in the Far-IR: Spitzer & Herschel

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Good news first...

- Spitzer has surveyed many 100's of nearby stars for excess far-IR emission (at 24 and 70 μm), including all TPF candidate stars.
- Many of these (all TPF stars) have also been observed with the IRS spectrograph (5-35 μm).
- The sensitivity of the observations has allowed us to quadruple the number of solar-type stars known to have debris disks.
- The overall detection rate is $\sim 15\%$.

Spitzer Detection Limits

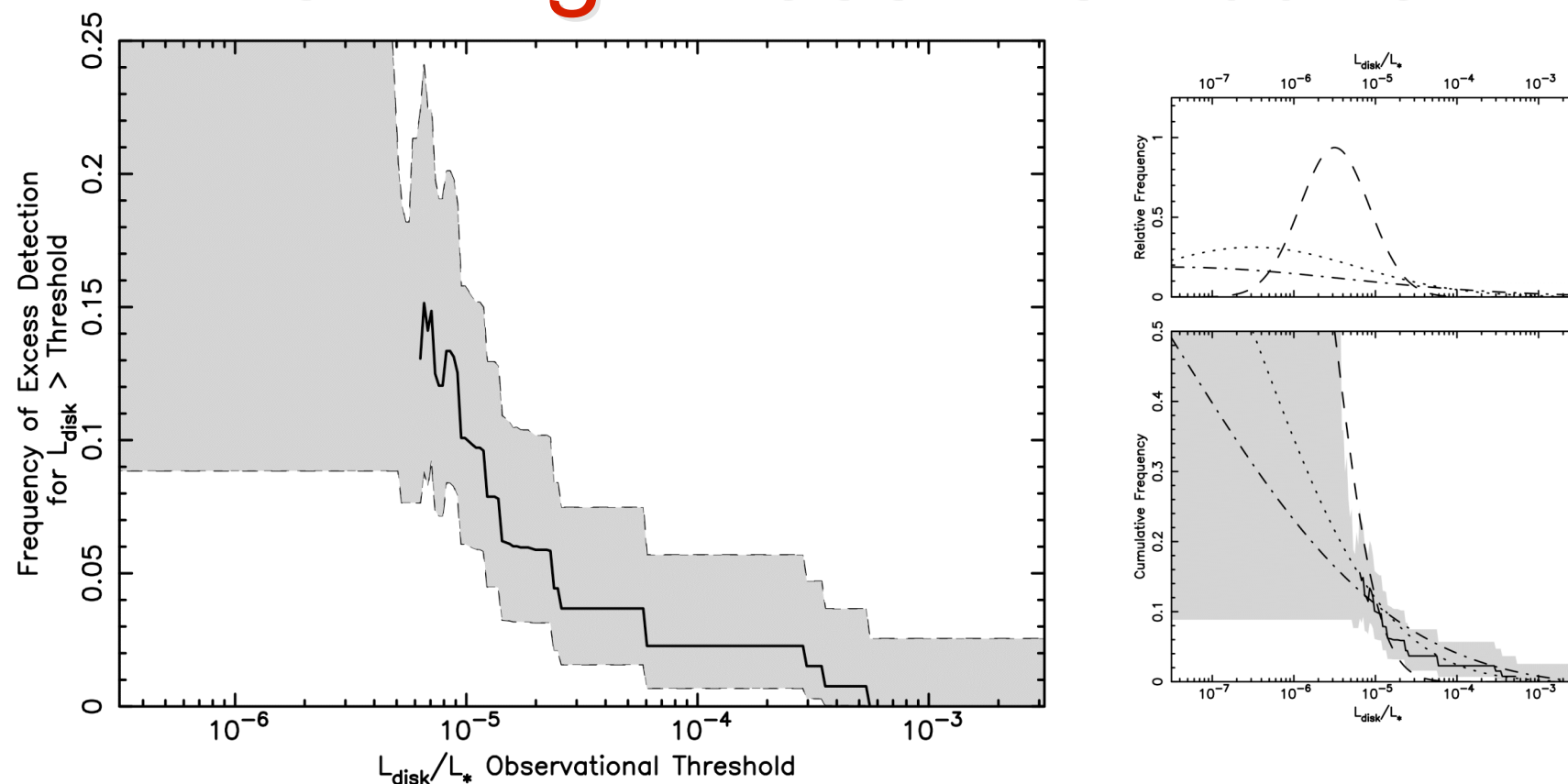


MIPS photometry at 70 μm can detect dust emission around solar-type stars as faint as $L_{\text{d}}/L_* < 10^{-5}$

IRS spectroscopy requires greater sensitivity relative to the stellar emission.

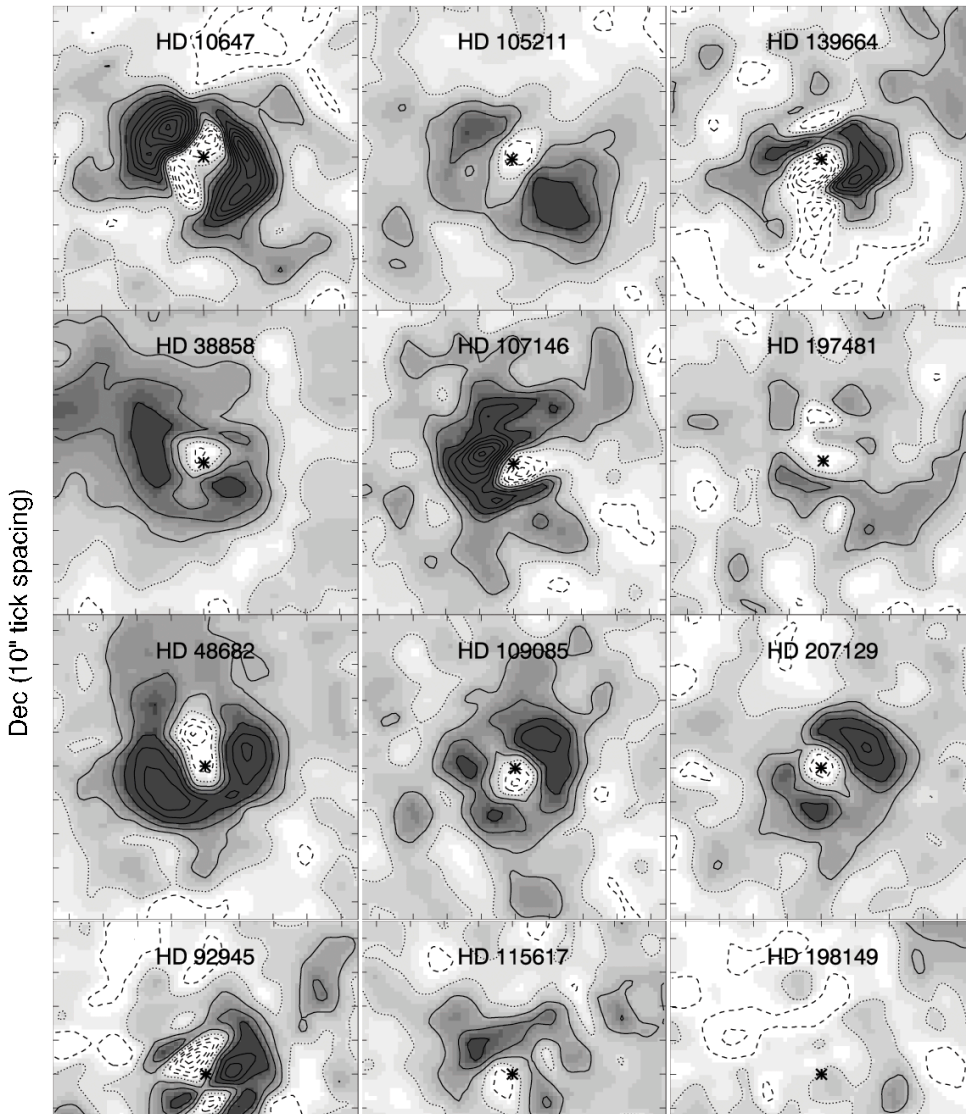
Overall detection rates are comparable ($\sim 15\%$).

Disk Brightness Distribution



Trend can be fit by a distribution of disk luminosities centered on a reasonable guess for the Solar System, i.e. consistent with us being an average system.

Solar-type debris disks resolved by Spitzer



Eleven marginally-resolved disks.

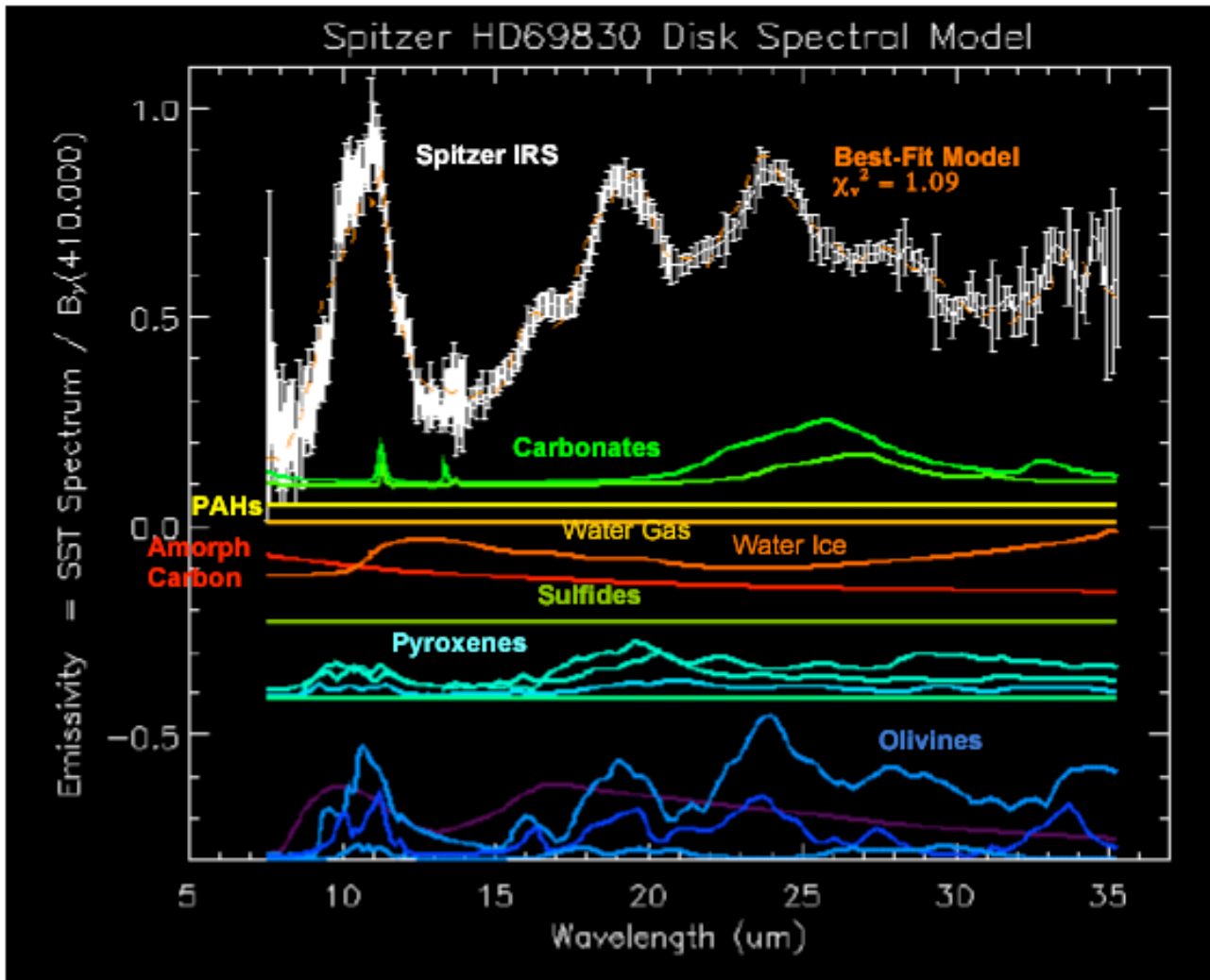
Typical orbital radius ~ 100 AU.

Four previously imaged with HST;
two more in follow-up.

Position angles and sizes match.

Sizes are a lot larger than
expectation from a simple
blackbody fit to the SED
(i.e. we're looking at small grains
that are \sim twice as hot as the
blackbody equilibrium).

Spectral Features



Not many solar-type stars have excess detected at 10 μm, but those that do generally show strong silicate emission.

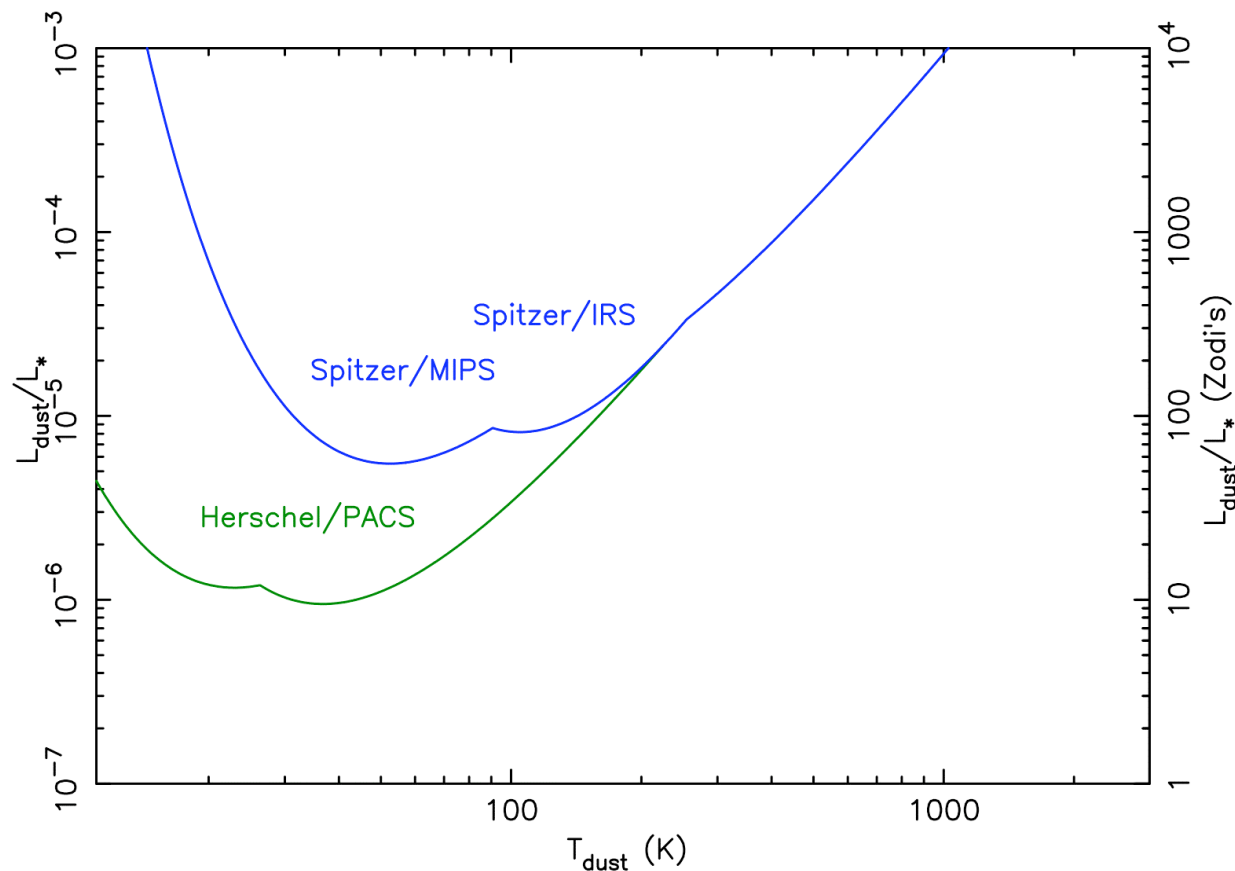
This enhancement may help with ground-based detections at 10 μm, particularly if the interferometer has some spectral resolving power.

Spitzer spectrum of HD 69830 (Beichman 2005) and model (Lisse 2007)

Spitzer summary

- Spitzer has identified many new debris disks around solar-type stars, with an overall detection rate of $\sim 15\%$.
- Typical find is analogous to, but brighter than, the Kuiper Belt, not the Asteroid Belt.
- There are now 11 systems (besides ours) known to have both planets and debris.
- We're typically looking at bright 100 AU rings; what does this tell us about dust at 1 AU?

Herschel Detection Limits



Herschel's PACS photometer (70, 100, and 160 μm) will be more sensitive than Spitzer to cold dust at 10's of AU.

Disks with $L_{\text{d}}/L_* < 10^{-6}$ will be detected, a level of emission comparable to the Solar System's Kuiper Belt.

Herschel summary

- Even better at detecting Kuiper Belt analogs
- Fainter disks will be detected, potentially allowing us to constrain the shape of the luminosity function.
- 4x larger telescope could resolve 100 disks (cf <20 by Spitzer).

